Central Coast Juvenile Herring Survey, August 2003

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by

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ABSTRACT

Henderson, S., Thompson, M., and Therriault, T.W. 2005. Central Coast juvenile herring survey, August 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2710: v + 36 p.

This Central Coast survey was conducted from August 5-17, 2003. Thirty-nine purse seine sets were made in Statistical Management Areas 6, 7, 8 and 9, from Meyers Passage in the north to Fish Egg Inlet in the south. The survey serves to address information gaps on the distribution, abundance, size and feeding habits of juvenile herring in these areas.

Twenty-two species of fish were recorded in the purse seine catches with herring being the most frequently captured. A total of 7225 juvenile herring were measured and weighed resulting in a distinctly bimodal length frequency distribution representing age-0+ and age-1+ fish. Age-0+, age-1+ and age-2+ or older herring occurred in 87.2%, 76.9% and 35.9% of the sets respectively. A total of 224 herring stomachs and 46 possible herring predator stomachs were analysed for stomach content. Twenty oblique plankton tows were performed during the survey. Juvenile calanoid copepods and *Pseudocalanus minutus* were the most prominent organisms encountered.

RÉSUMÉ

Henderson, S., Thompson, M., and Therriault, T.W. 2005. Central Coast juvenile herring survey, August 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2710: v + 36 p.

Ce relevé a été réalisé sur la Côte centrale entre le 5 et le 17 août 2003. Nous avons effectué 39 pêches à la senne à poche dans les secteurs statistiques 6, 7, 8 et 9, du passage Meyers au nord au bras Fish Egg au sud. Ce relevé vise à combler les lacunes en ce qui concerne la répartition, l'abondance, la taille et les habitudes alimentaires des jeunes harengs dans ces secteurs.

Vingt-deux espèces ont été observées dans les prises, le hareng venant en première place. Au total, nous avons mesuré et pesé 7 225 harengs juvéniles, et nous avons obtenu une distribution des fréquences de longueur nettement bimodale, représentant les poissons d'âge 0+ et d'âge 1+. Des harengs d'âge 0+, d'âge 1+ et d'âge 2+ ou davantage étaient présents respectivement dans 87,2 %, 76,9 % et 35,9 % des coups de senne. Au total, nous avons analysé le contenu stomacal de 224 harengs et de 46 prédateurs potentiels du hareng. Pendant la mission, nous avons aussi effectué 20 traits en oblique de filet à plancton. Les organismes les plus souvent observés dans ces traits étaient des copépodes calanoïdes juvéniles et le *Pseudocalanus minutus*.

INTRODUCTION

Pacific herring (*Clupea pallasi*) are an important commercial species and a vital forage species for many marine mammals, birds and other fish in British Columbia's coastal waters. Herring spawn principally on marine vegetation in the subtidal and upper intertidal zone between February and June, with peak spawning between March and April (Humphreys and Hourston 1978). Larvae hatch in two to three weeks, and disperse with surface currents, metamorphosing into juvenile herring at a length of ~25mm (Hourston and Haegele 1980). Herring are considered juvenile until they are three years of age and have joined the sexually mature spawning population (Hay and McCarter 1999). During daylight hours, juvenile herring congregate in schools, occasionally forming mixed aggregates with other pelagic species, close to shore near the bottom (Haegele 1997). At dusk, these fish migrate into surface waters to feed on plankton. During this time they are vulnerable to purse seine operations.

Relatively little is known about the distribution, abundance, size and feeding habits of juvenile herring in the Central Coast of British Columbia (Figure 1). In 2002, a juvenile herring survey was designed to address information gaps and learn about the general biology of herring in this area. The survey used an ecosystem based approach to biological sampling. Therefore, in addition to juvenile herring, all other fish species, plankton samples and predator stomach samples were retained for analysis. Juvenile herring stomach contents also were examined from six set locations. This approach will potentially provide a better understanding of the role and relationships juvenile herring have in Central Coast waters, and may provide an empirical forecast of recruitment to the herring roe fishery based on relative juvenile abundance.

METHODS

In 2003, the Central Coast juvenile herring survey was conducted from August 5-17. Thirty-nine sets were made at 12 locations within Statistical Management Areas 6, 7, 8 and 9 (Table 1). The study area extended from Meyers Passage in the north to Fish Egg Inlet in the south (Figures 2 and 3). The 2003 set locations were nearly identical to set locations used in 2002, the first year of this survey (Henderson et al. 2004). The sampling sites originally were chosen based on known historical herring spawning sites, and represent both nearshore and open water habitats (Haegele and Armstrong 2003).

Fish Sampling

The 12m, aluminium-hulled Fisheries Research Vessel *Walker Rock* was used for all fishing events. A 183m long and 27m deep seine net of knotless web, resulting in an area fished of ~2665m^2, was used for all fishing events. The body of the net had 46m of 22.2mm mesh at the tow end followed by 91m of 19.0mm mesh, and the bunt end was 46m of 9.5mm mesh. The net fished to a depth of 10m, and was able to retain fish greater than 30mm in length. All sets were made after dusk when herring are feeding near the surface. All sets were made "blind" at predetermined set locations. Up to four sets were completed per night, depending on location. No proposed sets were lost due to adverse weather or oceanic (tide) conditions. For most sets, it was possible to land the entire catch for biological sampling. When possible, a minimum of 200

herring from each juvenile age class (age-0+ and age-1) were retained in addition to any older herring. On occasion, it was not practical to land a large set in its entirety, so sub-sampling was necessary. When sub-sampling was necessary, a 40kg tote was filled with randomly selected fish and retained for biological sampling. The remainder of the set was released over the corkline, its size estimated as the number of totes released. The fish were sorted to species immediately after each set, and herring were further sorted to year-class based on visual observation. The number of juvenile herring caught in each set was determined by dividing the total catch weight by the age-specific mean weight of sub-sampled herring from each age class. The number of other species caught was determined in the same manner, with juvenile and adult salmon treated separately to minimize errors when calculating total catch (Table 2). All sorted fish were weighed, bagged and preserved in a 3.7% seawater formalin solution, with the exception of large predator species (e.g. adult salmon, dogfish and mackerel). These fish were individually weighed and measured in the field, and their stomachs were removed and preserved for later analysis at the Pacific Biological Station.

To minimize the effects of fish preservation, all fish samples were processed within eight weeks of collection. From each set, up to 200 herring in each age-class and all other fish species caught were identified, weighed and measured. Herring were measured to standard length; salmon to fork length; dogfish, hake and pollock to total length; and squid to distal mantle length. All other fish species were measured to standard length. Seventy herring, 50 age-0+ and 20 age-1+, from each of six selected sets were retained for stomach content analysis.

Plankton Sampling

Twenty stepped oblique plankton tows were performed during the survey, generally one tow every second seine set. The tows were always completed after dusk and immediately before or after a fishing event. Dual 19cm diameter bongo nets with 350µm mesh were used for sampling, resulting in 'left' and 'right' bongo plankton samples (only left samples were processed). The bongos were lowered to 20m (10m in shallow areas) and raised by an electric winch at a rate of 1m every 15sec (or 1m every 30sec for shallow areas). A General Oceanics® 2030R model flowmeter was attached to the left bongo to determine the volume of seawater filtered. Volume filtered was calculated using the following equation (McCarter and Hay 2002):

$$\mathbf{V = (A \cdot F \cdot K) / 999{,}999} \qquad \textbf{Equation 1}$$

Where:

V = volume of water filtered through the plankton net (m^3)
A = area of net opening ($0.02835 m^2$)
F = number of revolutions recorded by the flow meter (end reading – start reading)
K = standard speed rotor constant for 7cm rotor (26,873)

Upon retrieval, the bongo nets were washed with a high pressure deck hose, and the samples preserved in 3.7% seawater formalin.

In the laboratory, a volumetric splitter was used to reduce the sample size to a point where organisms could be conveniently counted and identified in a counting tray using a stereo

microscope under 30X magnification. Sample splitting continued until a target size of roughly 300 organisms was reached (Thompson et al. 2003).

Generally, plankters were not identified to species but classified into readily recognizable categories. Copepods were however identified to species when possible. Densities for all plankters were determined and expressed as plankters·m^{-3}.

STOMACH CONTENTS

Herring

Juvenile herring stomachs were retained from six set locations: Set 1 (Fish Egg Inlet), Set 5 (Kwakshua Channel), Set 22 (Kitasu Bay), Set 28 (Powell Anchorage), Set 31 (Spiller Channel) and Set 36 (Hunter Channel) for further analysis. From each of these sets, 20 age-0+ and 20 age-1+ herring stomach samples were extracted in the laboratory and preserved in ~3.7% formalin in individually labelled vials. Each stomach was rated for fullness (empty, trace, half full and full), state of digestion (fresh, partly, mostly and totally) and, when possible, its contents identified and enumerated. Stomach contents were categorized into 28 groups of organisms representing 10 phyla. Copepods were further classified to species.

Other Species

Stomachs of possible herring predators; pink, coho, chum and sockeye salmon, chub mackerel, spiny dogfish shark, and starry flounder were sampled (fish >25cm). Fish were weighed and measured in the field, and their stomachs were removed and preserved in ~3.7% seawater formalin. Stomachs were analyzed for prey items, fullness and level of digestion. Identifiable contents were weighed and measured.

RESULTS

Thirty-nine sets were made during the 2003 survey; four in section 091 (Fish Egg Inlet), three in section 085 (Kwakshua Channel), six in section 076 (Kildidt Sound), four in section 074 (Thompson Bay), six in section 067 (Laredo Inlet), four in section 077 (Milbanke Sound), six in section 072 (Powell Anchorage), four in section 073 (Bella Bella) and two in section 084 (Burke Channel). Section numbers and names correspond to the classification by Midgley (2003), and should not be confused with the individual set location names (Table 1).
All 2003 set locations correspond to set locations used in the 2002 Central Coast survey, with the following exceptions. Two new sets (38 and 39) were made further inland (NW) in Burke Channel, replacing a 2002 set near the entrance (omitted due to strong tide). Also, one new set was made in Spider Anchorage (set 13), which was aborted in 2002 due to adverse weather conditions (Figures 2 and 3, Table 1).

Twenty-two species of fish and invertebrates from 4 phyla were identified in the seine catches. Fish species most frequently encountered (>15% occurrence) included: Pacific herring, pink salmon, chinook salmon, walleye pollock, coho salmon, shiner perch and capelin. Opal squid also were encountered in 43.5% of the sets (Tables 2 and 3).

Herring

A total of 7225 herring were measured resulting in a length frequency distribution that was distinctly bimodal. Based on this length frequency distribution, the length designations for the two juvenile herring age-classes are (Figure 4):

0+ = herring less than or equal to 85mm standard length
1+ = herring between 86mm and 129mm standard length
2+ or older = herring greater than or equal to 130mm standard length

Age-0+ herring occurred in 87.2% of the sets (Table 3). The largest catches of age-0+ herring by weight occurred in Kitasu Bay (section 067), Fish Egg Inlet (section 091) and Hunter Channel (section 073). Table 4 shows the average length and weight, and the total herring catch weight for age-0+ herring at each set location. The mean length of all sampled age-0+ herring (n=3933) was 61.70mm.

Age-1+ herring occurred in 76.9% of the sets (Table 3). The largest catches of age-1+ herring occurred in Fish Egg Inlet (section 091), Kitasu Bay (section 067) and Kildidt Sound (section 076). Table 4 shows the average length and weight, and the total herring catch weight for age-1+ herring at each set location. The mean length of all sampled age-1+ herring (n=3129) was 103.29mm.

Age-2+ herring occurred in 35.9% of the sets (Table 3). The largest catches occurred in Kildidt Sound (section 076) and Kwakshua Channel (section 085). No age-2+ herring were caught in Spider Anchorage, East Higgins Passage or Powell Anchorage. The mean length of all sampled age-2+ herring (n=163) was 145.60mm.

Herring length frequency distributions varied by location. The histograms display the length frequency for sampled herring only (Figure 5) but provide a representation of juvenile herring length distribution during the survey. The relationship between length and weight for all sampled herring was determined by fitting a logistic function to the length-weight data (Figure 6).

Plankton

There were 26 categories of organisms identified in 20 plankton samples (Table 5 and 6). Most samples contained a mild to heavy amount of Coscinodiscus diatoms, but were not quantified. An average of 12.31m^3 of water was filtered per plankton tow. Copepods occurred in all samples. Unidentifiable juvenile calanoid copepods and *Pseudocalanus minutus* were the only organisms to occur in all samples. Amphipods, barnacle larvae, coelenterates, crab megalopea and zoea, larval euphausiids, larvaceans, calanoid copepods (*Acartia longiremis*, *Centropages abdominals*, *Metridia pseudopacifica*, *Pseudocalanus minutus*), and unidentifiable juvenile calanoid copepods made up >75% of samples. Ctenophores, ectoprocts, prosobranch gastropods, polychaetes, miscellaneous eggs (mainly euphausiid) and the calanoid copepod *Calanus marshallae* occurred in 50 – 74% of samples. Chaetognaths, adult euphausiids, teleost larvae,

siphonophores, calanoid copepods (*Calanus pacificus*, *Eucalanus elongates*, *Paracalanus parvus*, *Tortanus discaudatus*), and the cyclopoid copepod *Oithona sp.* occurred in 25 – 49% of samples. Barnacle nauplii, isopods (cumaceans and mysids), echinoderms, euphausiids, ostracods, pelecypods, calanoid copepods (*Acartia sp.*, *Calanus sp.*, *Eucalanus bungii*, *Gaidius sp.*, *Oncaea borealis*) the cyclopoid copepod *Corcaeus anglicus*, and unidentified copepod nauplii, cyclopoid copepods and harpacticoid copepods occurred in <25% of samples (Table 7).

Herring Stomachs

A total of 121 age-0+ herring stomachs were examined (Table 8). Of these, 117 contained identifiable stomach contents. On average, unidentifiable calanoid copepods occurred most frequently followed by barnacle nauplii, *Podon sp.* and *Evadne sp.* cladocerans and coscinodiscus diatoms (Table 9).

A total of 103 age-1+ herring stomachs were examined (Table 8). Of these, 92 contained identifiable stomach contents. On average, crab zoea occurred most frequently, followed by unidentifiable calanoid copepods, coscinodiscus diatoms and turbellarians (Table 10).

Other Species

Pink, coho, chum and sockeye salmon, chub mackerel, spiny dogfish shark, and starry flounder were sampled. A total of 46 possible herring predator stomachs were sampled, with only seven stomachs containing identifiable herring (Table 11). Several stomachs had material that was unidentifiable, so only the stomach content weight was recorded. Three salmon species (pink, coho and chum) were found to contain juvenile herring (age-0+ and age-1+). Chub mackerel stomachs contained euphausiids but no herring.

CONCLUSION

Thirty-nine stations were sampled resulting in 22 different fish species recorded from the purse seine sets. A total of 7225 herring were measured and weighed creating a distinct bimodal histogram representing two juvenile herring age groups. A total of 224 herring stomachs were examined for contents. The dominant prey item was calanoid copepods for age-0+ herring and crab zoea for age-1+ herring. Forty-six possible herring predator stomachs were examined, with only seven stomachs containing identifiable juvenile herring. Twenty plankton tows were performed resulting in unidentifiable juvenile calanoid copepods and *Pseudocalanus minutus* being the most prominent organisms.

ACKNOWLEDGMENTS

This study was funded by the Herring Conservation and Research Society (HCRS), and we are grateful for their continuing support. All plankton and herring stomach samples were processed by Carol Cooper of Zotec Services. Bob Armstrong of Armstrong Biotech Services and Dennis Chalmers conducted the field work and sampling. Fisheries and Oceans provided the research vessel and laboratory facilities. Kristen Daniel provided editorial comments regarding ArcView© maps.

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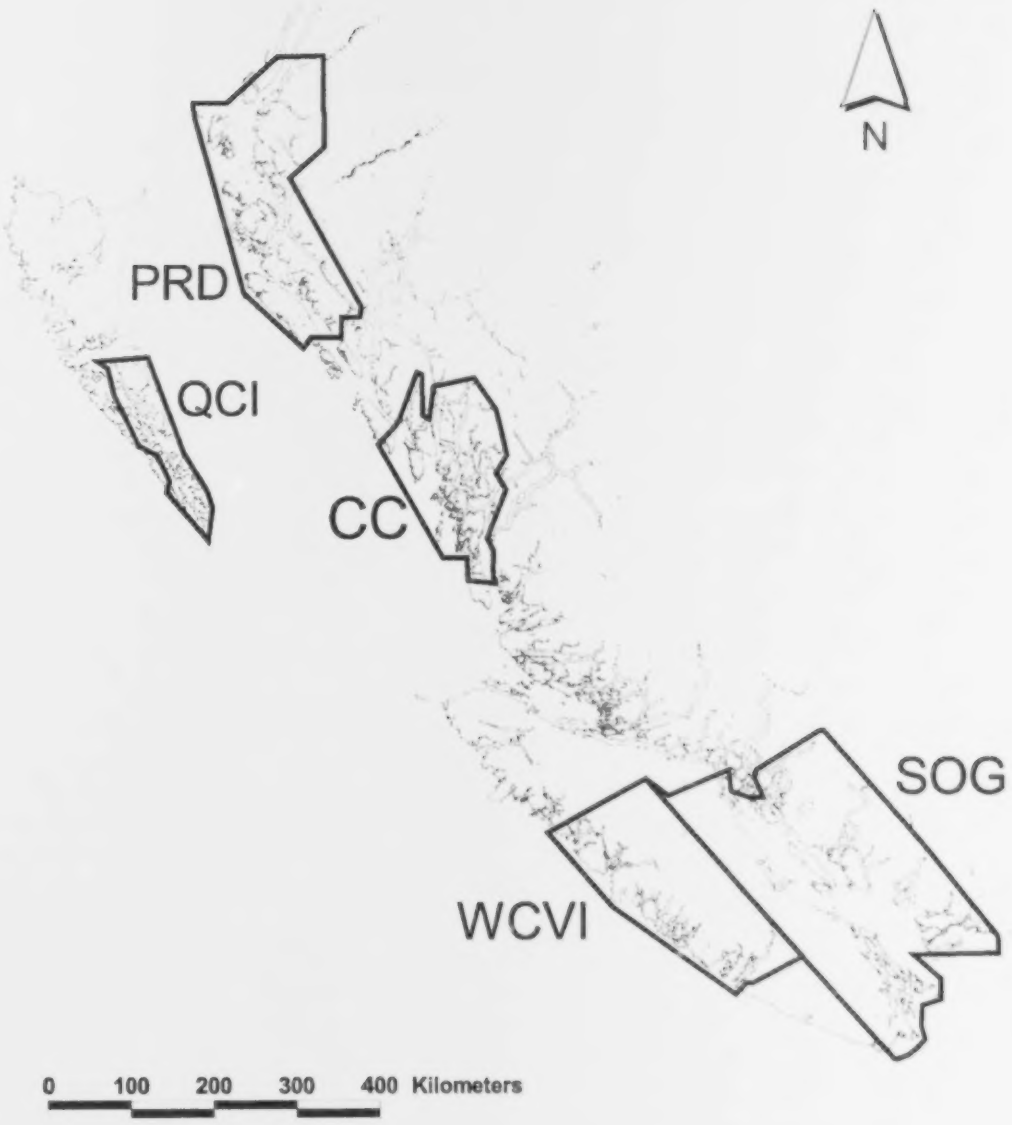

Figure 1. The five major British Columbia herring stock assessment regions: Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), west coast Vancouver Island (WCVI) and the Strait of Georgia (SOG).

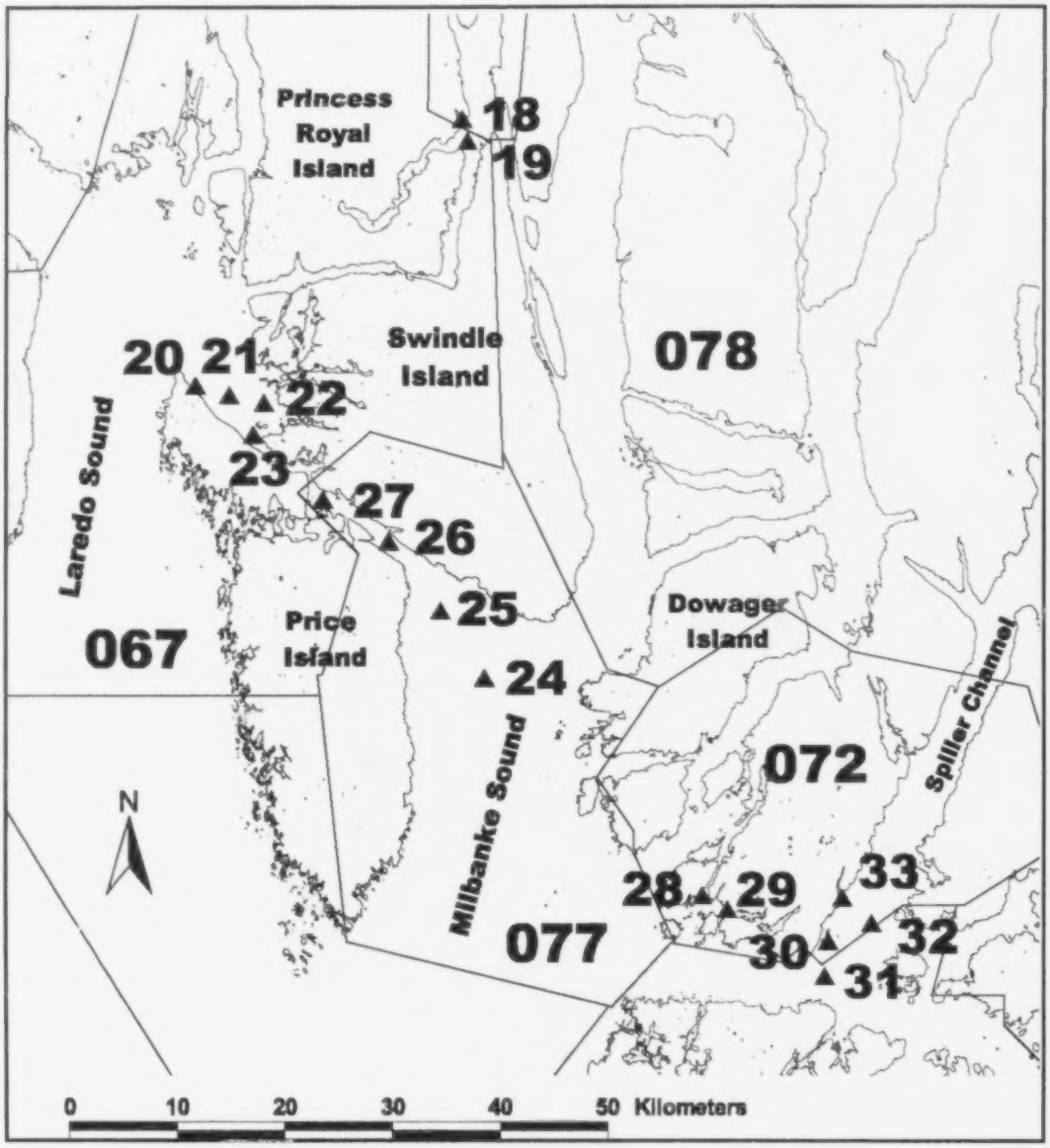

Figure 2. Northern Central Coast stock assessment area with set locations (triangles) and section numbers (large 3-digit numbers).

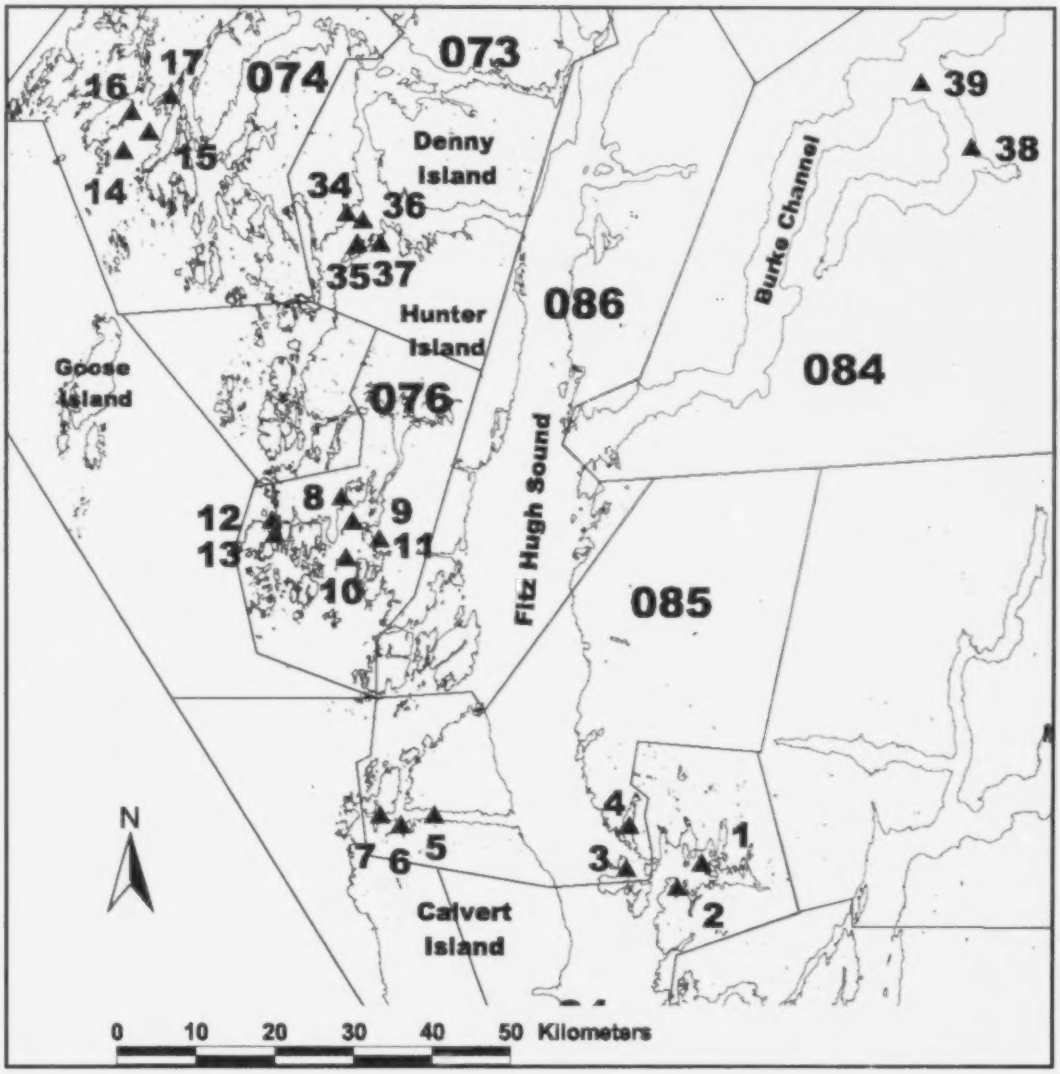

Figure 3. Southern Central Coast stock assessment area with set locations (triangles) and section numbers (large 3-digit numbers).

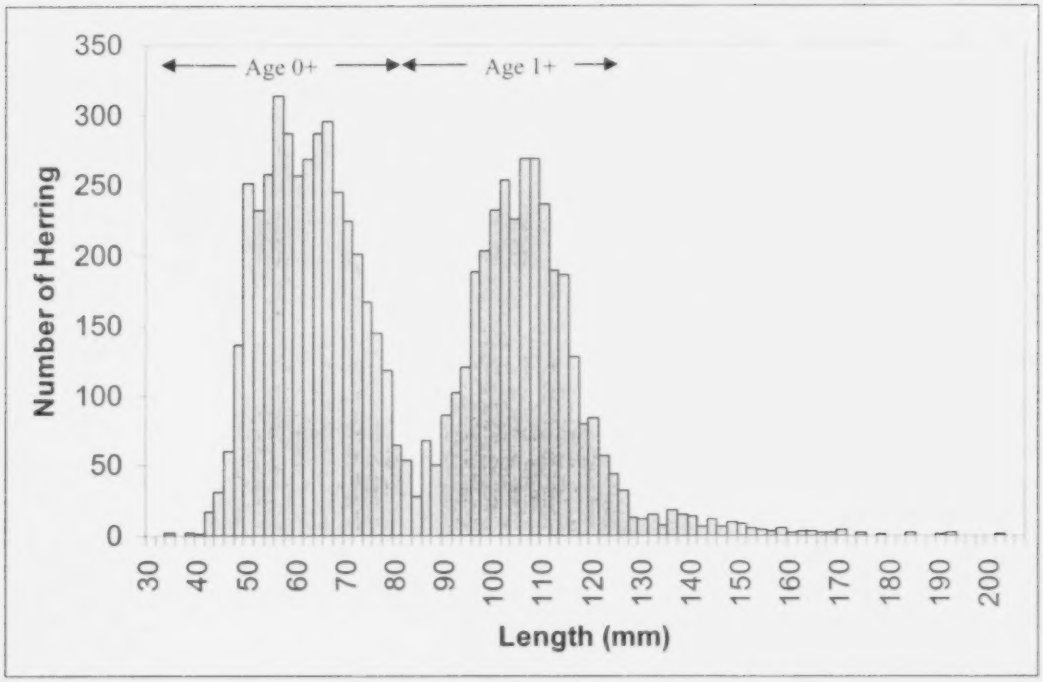

Figure 4. Length frequency distribution of all sampled herring.

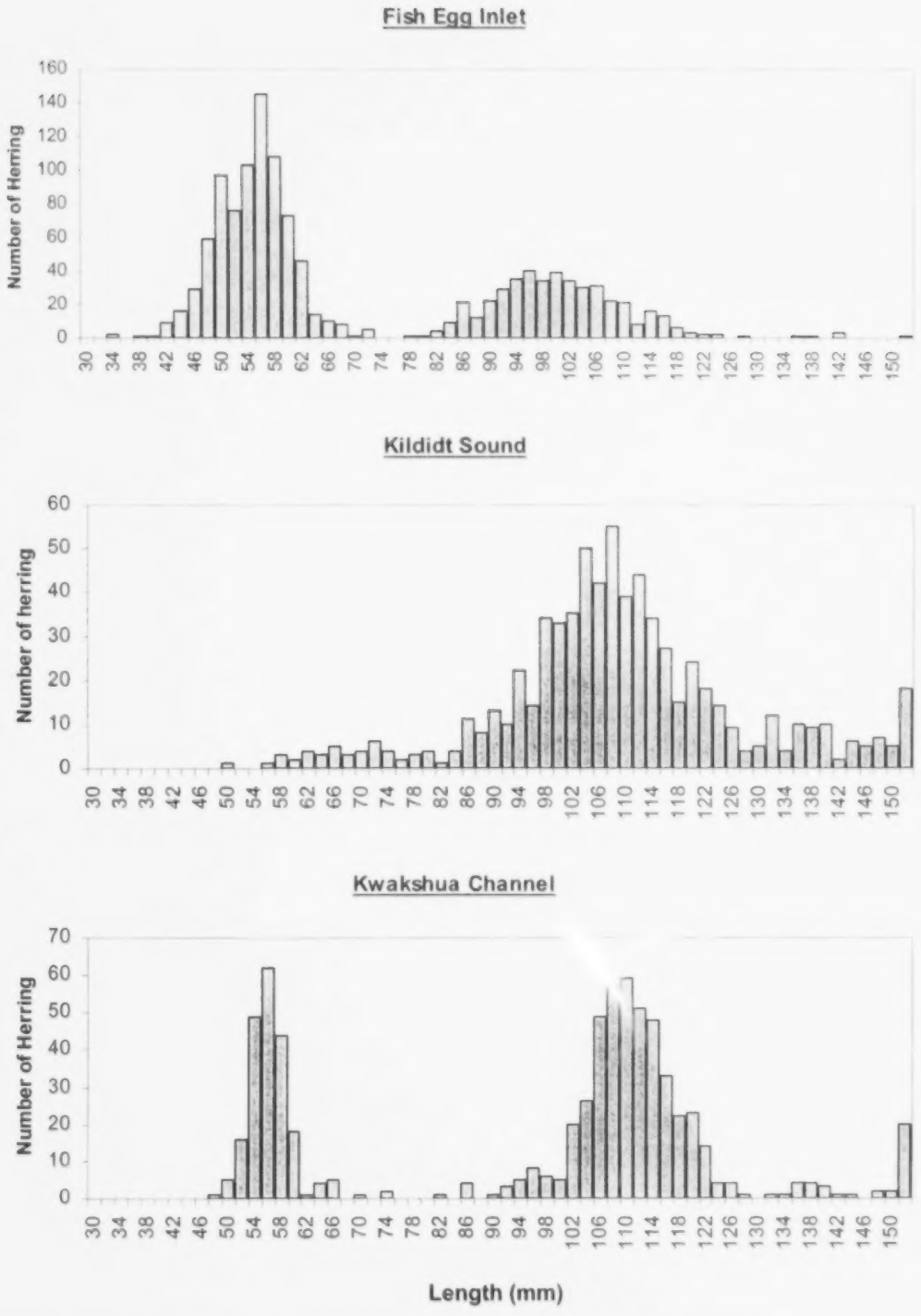

Figure 5. Length frequency distributions of sampled herring by set location.

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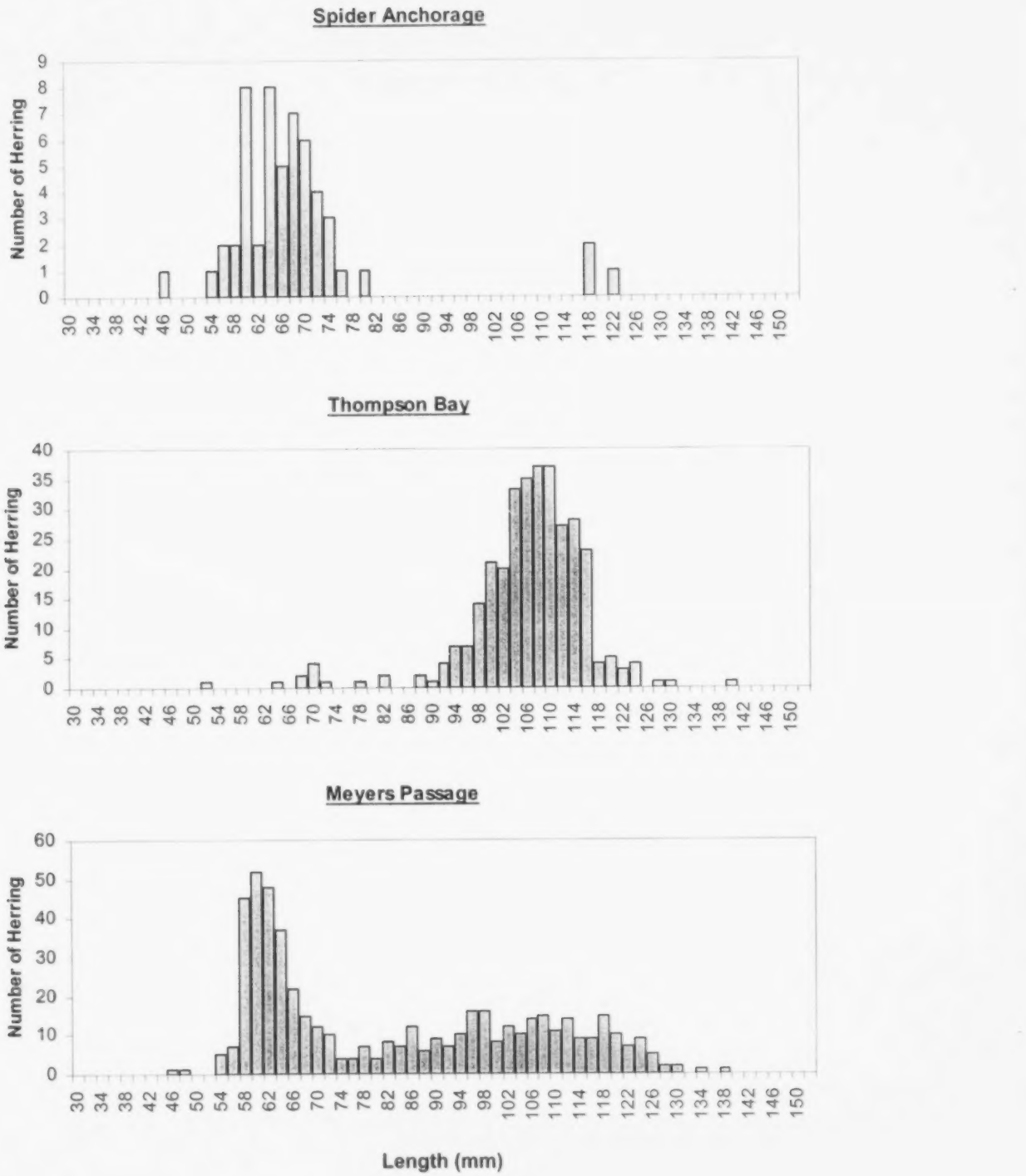

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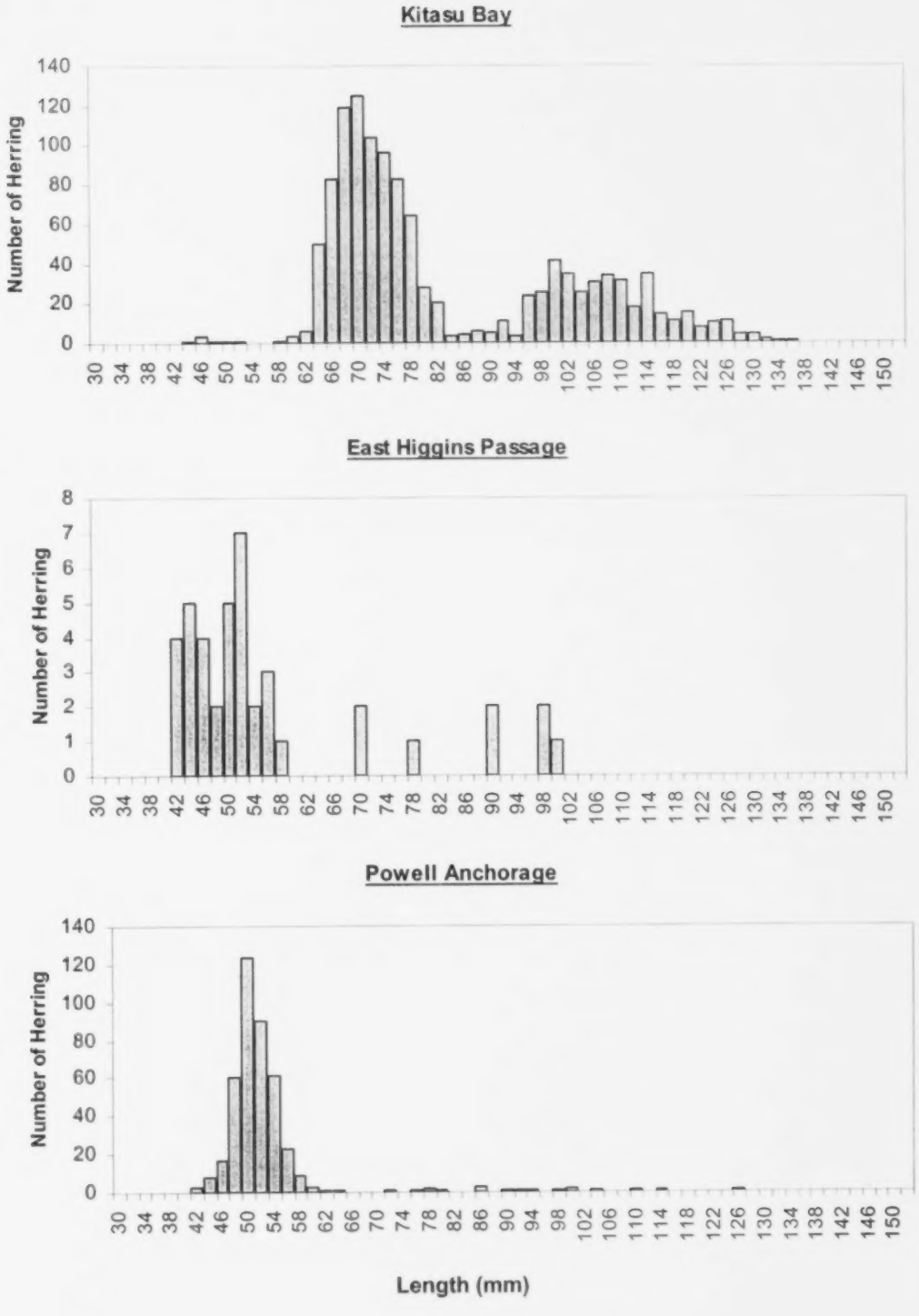

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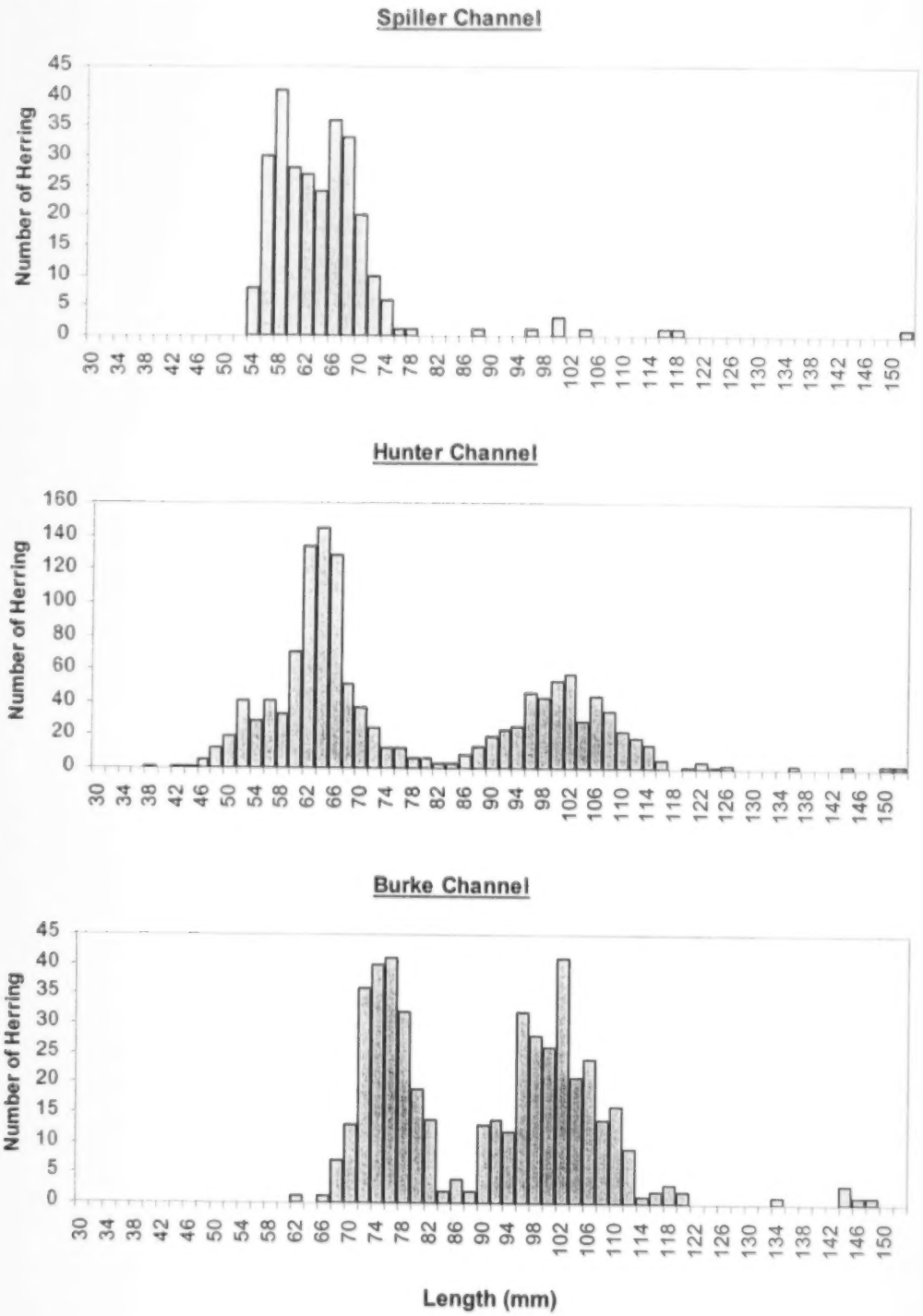

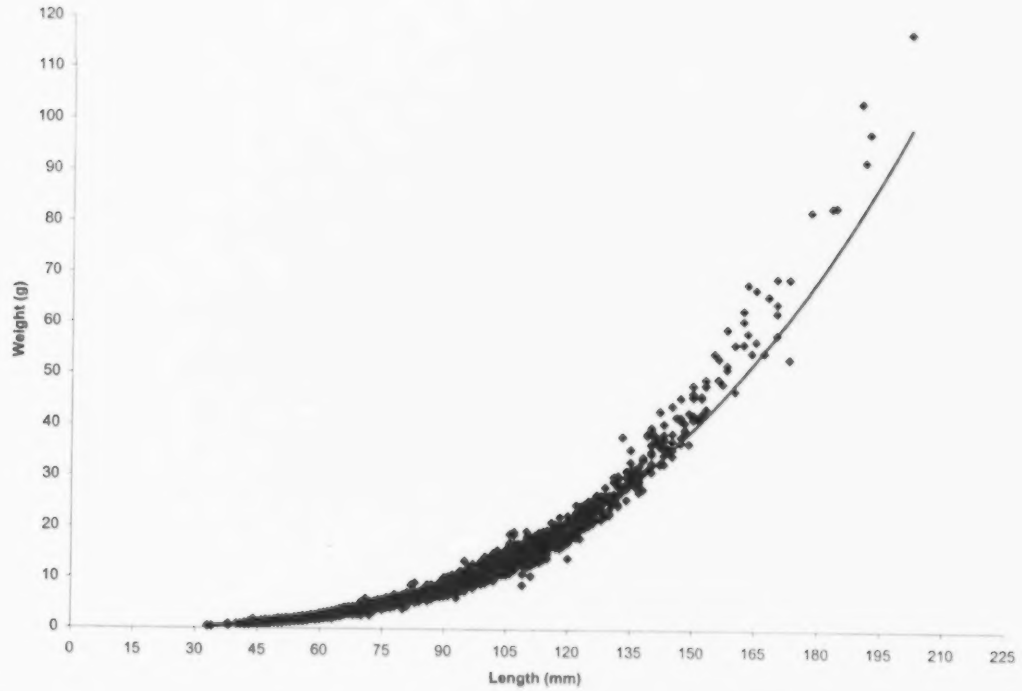

Figure 6. Length-weight relationship for all sampled herring ($W = 7.62 \times 10^{-6} L^{3.085}$, $R^2 = 0.9904$, $n = 7225$).

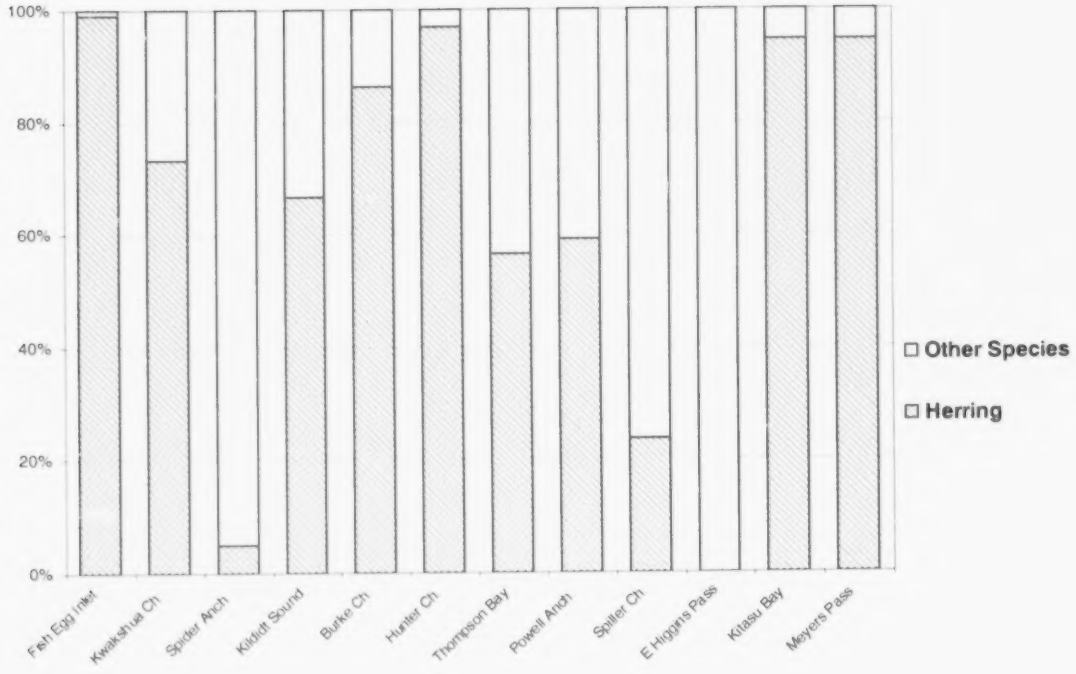

Figure 7. Proportion of herring relative to catch by location.

Table 1. Details of the 39 sets made during the 2003 Central Coast juvenile herring survey.

Set	Month	Day	Set Code	Station	Section	Set Location Name	DD Lat (N)	DD Long (W)	Tow Time
1	8	5	1	1	091	Fish Egg Inlet	51.6210	127.7450	2245
2	8	5	1	2	091	Fish Egg Inlet	51.6040	127.7730	2420
3	8	5	1	3	091	Fish Egg Inlet	51.6170	127.8320	130
4	8	5	1	4	091	Fish Egg Inlet	51.6470	127.8280	230
5	8	6	2	2	085	Kwakshua Channel	51.6550	128.0530	2245
6	8	6	2	3	085	Kwakshua Channel	51.6480	128.0910	2340
7	8	6	2	4	085	Kwakshua Channel	51.6550	128.1150	2430
8	8	7	4	2	076	Kildidt Sound	51.8790	128.1590	2230
9	8	7	4	1	076	Kildidt Sound	51.8620	128.1460	2320
10	8	7	4	3	076	Kildidt Sound	51.8370	128.1540	2415
11	8	7	4	4	076	Kildidt Sound	51.8497	128.1155	120
12	8	8	3	1	076	Spider Anchorage	51.8630	128.2380	2220
13	8	8	3	2	076	Spider Anchorage	51.8530	128.2352	2350
14	8	9	5	1	074	Thompson Bay	52.1210	128.4070	2230
15	8	9	5	2	074	Thompson Bay	52.1340	128.3780	2315
16	8	9	5	3	074	Thompson Bay	52.1480	128.3980	2400
17	8	9	5	4	074	Thompson Bay	52.1590	128.3540	110
18	8	11	6	2	067	Meyers Passage	52.6840	128.5770	2215
19	8	11	6	1	067	Meyers Passage	52.6730	128.5720	2300
20	8	12	7	1	067	Kitasu Bay	52.5500	128.7990	2220
21	8	12	7	2	067	Kitasu Bay	52.5450	128.7710	2340
22	8	12	7	3	067	Kitasu Bay	52.5410	128.7420	2455
23	8	12	7	4	067	Kitasu Bay	52.5250	128.7510	210
24	8	13	8	1	077	East Higgins Pass	52.4020	128.5580	2210
25	8	13	8	2	077	East Higgins Pass	52.4360	128.5950	2325
26	8	13	8	3	077	East Higgins Pass	52.4710	128.6380	2450
27	8	13	8	4	077	East Higgins Pass	52.4920	128.6930	145
28	8	14	9	1	072	Powell Anchorage	52.2910	128.3760	2230
29	8	14	9	2	072	Powell Anchorage	52.2840	128.3550	2320
30	8	15	10	1	072	Spiller Channel	52.2500	128.2740	2210
31	8	15	10	2	072	Spiller Channel	52.2680	128.2710	2255
32	8	15	10	3	072	Spiller Channel	52.2770	128.2350	2335
33	8	15	10	4	072	Spiller Channel	52.2900	128.2590	2430
34	8	16	11	4	073	Hunter Channel	52.0780	128.1530	2205
35	8	16	11	2	073	Hunter Channel	52.0570	128.1410	2245
36	8	16	11	3	073	Hunter Channel	52.0730	128.1350	2330
37	8	16	11	1	073	Hunter Channel	52.0570	128.1150	2430
38	8	17	12	2	084	Burke Channel	52.1239	127.4380	2135
39	8	17	12	3	084	Burke Channel	52.1693	127.4946	2335

Section	Official herring management section names
067	Laredo Inlet
072	Powell Anchorage
073	Bella Bella
077	Milbanke Sound

Table 2. Species* quantity and weights by set.

Set	Location Name	Species	Quantity	Weight (g)
1	Fish Egg Inlet	**0+ Herring**	34692	15410
		1+ Herring	7920	18790
		Capelin	701	182
		Juvenile Pollock	16	26
		Three-spine Stickleback	4	3
2	Fish Egg Inlet	**0+ Herring**	20460	35600
		1+ Herring	60	600
		Shiner Perch	5	45
3	Fish Egg Inlet	**0+ Herring**	20588	21000
		1+ Herring	545	3600
		2+ Herring	12	227
		Juvenile Chinook salmon	2	52
		Juvenile Pollock	12	472
		Shiner Perch	2	25
4	Fish Egg Inlet	**0+ Herring**	4715	5800
		1+ Herring	9	80
5	Kwakshua Channel	**0+ Herring**	2486	4600
		1+ Herring	620	9800
		2+ Herring	31	1800
		Juvenile Chinook salmon	2	222
		Juvenile Pink salmon	1	41
6	Kwakshua Channel	**0+ Herring**	8	21
		1+ Herring	135	2055
		Squid		4000
7	Kwakshua Channel	**0+ Herring**	1	4
		1+ Herring	164	2260
		2+ Herring	3	94
		Adult Pink salmon	2	3200
		Shiner Perch	2	-
		Three-spine Stickleback	2	-
8	Kildidt Sound	**0+ Herring**	26	90
		1+ Herring	439	6000
		Poacher	1	0.5
		Squid	-	2100

Table 2 continued...

Set	Location Name	Species	Number	Weight (g)
9	Kildidt Sound	**0+ Herring**	12	40
		1+ Herring	914	13800
		2+ Herring	70	2700
		Juvenile Hake	30	449
		Squid	-	1500
10	Kildidt Sound	**0+ Herring**	10	42
		1+ Herring	427	5400
		2+ Herring	11	401
		Juvenile Chinook salmon	3	915
		Juvenile Hake	1	16
		Squid	-	7900
11	Kildidt Sound	Pacific Sardine	6	1330
12	Spider Anchorage	**0+ Herring**	14	38
		Juvenile Cono salmon	1	17
		Squid	-	2000
13	Spider Anchorage	**0+ Herring**	37	112
		Juvenile Coho salmon	1	108
		Juvenile Pink salmon	5	510
		Squid	-	300
14	Thompson Bay	**1+ Herring**	349	5100
		2+ Herring	2	60
		Squid	-	1300
15	Thompson Bay	**0+ Herring**	2	6
		1+ Herring	130	1800
		Spiny Dogfish	1	86
		Squid	-	3000
16	Thompson Bay	**0+ Herring**	8	39
		1+ Herring	4	45
		Shiner Perch	1	15
		Squid	-	20
17	Thompson Bay	**0+ Herring**	2	4
		Juvenile Hake	1	4
		Squid	-	1000
18	Meyers Passage	**0+ Herring**	9862	28600
		1+ Herring	42	574
		2+ Herring	1	27
		Adult Pink salmon	1	1600

Table 2 continued...

Set	Location Name	Species	Number	Weight (g)
19	Meyers Passage	**0+ Herring**	91	272
		1+ Herring	513	6700
		2+ Herring	2	50
		Juvenile Pollock	1	141
20	Kitasu Bay	**0+ Herring**	54917	49700
		1+ Herring	24	33
		Adult Pink salmon	3	6200
		Capelin	84	109
		Juvenile Rockfish	6	3
21	Kitasu Bay	**0+ Herring**	5900	15380
		1+ Herring	4827	27610
		2+ Herring	5	77
		Juvenile Coho salmon	2	129
		Juvenile Pink salmon	3	53
		Squid	5	-
		Whitebait Smelt	3	15
22	Kitasu Bay	**0+ Herring**	4802	15800
		1+ Herring	1401	19100
		2+ Herring	5	127
		Adult Coho salmon	2	7700
		Adult Pink salmon	1	2000
		Juvenile Chinook salmon	6	942
		Juvenile Coho salmon	11	1570
		Juvenile Pink salmon	1	19
		Squid	-	1300
23	Kitasu Bay	**0+ Herring**	879	3500
		1+ Herring	4	38
		Juvenile Chinook salmon	4	455
		Shiner Perch	1	16
		Sockeye	1	1500
		Squid	8	-
24	East Higgins Pass	Adult Chum salmon	1	4000
		Adult Pink salmon	1	2100
		Juvenile Coho salmon	4	652
		Juvenile Pink salmon	26	711
		Mackeral	26	53100

Table 2 continued...

Set	Location Name	Species	Number	Weight (g)
25	East Higgins Pass	Adult Chum salmon	2	8100
		Adult Pink salmon	2	3300
		American Shad	1	827
		Juvenile Chinook salmon	3	622
		Juvenile Pink salmon	8	202
		Mackeral	24	50100
26	East Higgins Pass	Adult Chum salmon	1	2400
		Juvenile Pink salmon	1	2100
27	East Higgins Pass	**0+ Herring**	36	51
		1+ Herring	5	48
		Spiny Dogfish	3	4300
28	Powell Anchorage	**0+ Herring**	5608	8300
		Adult Chum salmon	1	6000
		Juvenile Pollock	5	374
		Shiner Perch	1	3
		Squid	17	500
		Starry Flounder	1	1800
29	Powell Anchorage	**0+ Herring**	3289	5000
		1+ Herring	13	147
		Juvenile Pollock	10	573
		Shiner Perch	14	55
30	Spiller Channel	**0+ Herring**	6	19
		1+ Herring	1	12
		2+ Herring	1	58
		Adult Coho salmon	1	2500
		Juvenile Chinook salmon	1	154
		Squid	2	-
31	Spiller Channel	**0+ Herring**	200	502
32	Spiller Channel	**0+ Herring**	42	129
		1+ Herring	5	61
33	Spiller Channel	**0+ Herring**	17	47
		1+ Herring	2	24
		Juvenile Chinook salmon	1	108

Table 2 continued...

Set	Location Name	Species	Number	Weight (g)
34	Hunter Channel	**0+ Herring**	1148	3100
		1+ Herring	535	6000
		2+ Herring	8	309
		Capelin	19	32
		Juvenile Pollock	22	1290
35	Hunter Channel	**0+ Herring**	12755	41452
		1+ Herring	532	6347
		Capelin	2	11
		Juvenile Pollock	19	1478
36	Hunter Channel	**0+ Herring**	13723	41032
		1+ Herring	420	5166
		Capelin	16	24
		Juvenile Chinook salmon	1	36
		Juvenile Pollock	2	175
37	Hunter Channel	**0+ Herring**	9026	19044
		1+ Herring	64	555
		Capelin	72	49
		Squid	2	-
38	Burke Channel	**0+ Herring**	7643	36992
		1+ Herring	518	6029
		2+ Herring	8	283
		Adult Pink salmon	2	3800
		Juvenile Smelt	3	30
		Spiny Dogfish	2	3300
		Squid	1	-
		Three-spine Stickleback	7	20
39	Burke Channel	**0+ Herring**	8	40
		1+ Herring	139	1863
		2+ Herring	4	149
		Juvenile Coho salmon	4	43
		Juvenile Pink salmon	1	24
		Three-spine Stickleback	8	16

* Invertebrates such as euphausiids (Phylum Arthropoda), comb jellies (phylum Ctenophora) and jellyfish (Phylum Cnidaria) were frequently encountered but not included in this table due to quantifying difficulties.

Table 3. Percent species* occurrence in all 2003 Central Coast sets.

Common Name	Scientific Name	Set Numbers	Percent Occurrence (%)
0+ Herring	*Clupea pallasi* in year of birth	1,2,3,4,5,6,7,8,9,10,12,13,15,16,17,18,19,20,21,22, 23,27,28,29,30,31,32,33,34,35,36,37,38,39	87.2
1+ Herring	*Clupea pallasi* in year after birth	1,2,3,4,5,6,7,8,9,10,14,15,16,18,19,20,21,22,23, 27,29,30,32,33,34,35,36,37,38,39	76.9
2+ Herring	*Clupea pallasi* in 2nd year after birth	3,5,7,9,10,14,18,19,21,22,30,34,38,39	35.9
No Herring caught		11,24,25,26	10.3
Opal squid	*Loligo opalescens*	6,7,8,9,10,12,13,14,15,16,17,21,22,23,28,29,37	43.5
Pink salmon	*Oncorhyncus gorbuscha*	5,7,13,18,20,21,22,24,25,26,38,39	30.8
Chinook salmon	*Oncorhyncus tshawytscha*	3,5,10,22,23,25,30,33,36	23.1
Walleye pollock	*Theragra chalcogramma*	1,3,19,28,29,34,35,36	20.5
Coho salmon	*Oncorhyncus kisutch*	12,13,21,22,24,30,39	18.0
Shiner perch	*Cymatogaster aggregata*	2,3,7,16,23,28,29	18.0
Capelin	*Mallotus villosus*	1,20,34,35,36,37	15.4
Chum salmon	*Oncorhyncus keta*	24,25,26,28	10.3
Three-spine stickleback	*Gasterosteus aculeatus*	1,7,38,39	10.3
Pacific hake	*Merluccius productus*	9,10,17	7.7
Spiny dogfish	*Squalus acanthias*	15,27,38	7.7
Red squid	*Berryteuthis magister*	30,38	5.1
Chub mackeral	*Scomber japonicus*	24,25	5.1
Sockeye salmon	*Oncorhyncus nerka*	23	2.6
Whitebait smelt	*Allosmerus elongatus*	21	2.6
Surf smelt	*Hypomesus pretiosus*	38	2.6
Northern spearnose poacher	*Agonopsis vulsa*	8	2.6
Pacific sardine	*Sardinops sagax*	11	2.6
Rockfish	*Sebastes sp.*	20	2.6
American shad	*Alosa sapidissima*	25	2.6
Starry flounder	*Platichthys stellatus*	28	2.6

*Invertebrates such as euphausiids (Phylum Arthropoda), comb jellies (Phylum Ctenophora) and jellyfish (Phylum Cnidaria) were not quantified.

Table 4. Mean lengths, weights and total catch weights of age-0+ and age-1+ herring by set location. Herring management sections in brackets.

Set Location	Mean 0+ Length (mm)	Mean 0+ Weight (g)	Total Catch Weight 0+ (Kg)	Mean 1+ Length (mm)	Mean 1+ Weight (g)	Total Catch Weight 1+ (Kg)
Fish Egg Inlet (091)	55.1	1.78	145.040	100.5	11.37	83.040
Kwakshua Channel (085)	56.3	1.94	4.625	109.8	14.92	14.115
Kildidt Sound (076)	71.3	4.00	0.172	106.9	13.88	25.200
Spider Anchorage (076)	64.8	2.93	0.149	0	0	0
Thompson Bay (074)	69.9	4.10	0.049	107.0	14.30	6.945
Meyers Passage (067)	64.2	3.03	28.872	105.8	13.42	7.274
Kitasu Bay (067)	70.9	4.16	340.570	106.6	14.05	60.751
East Higgins Passage (077)	50.5	1.40	0.051	95.0	9.61	0.048
Powell Anchorage (072)	51.1	1.53	13.300	101.1	12.12	0.147
Spiller Channel (072)	62.6	2.63	0.696	102.1	12.29	0.098
Hunter Channel (073)	62.3	2.77	104.628	100.9	11.58	17.968
Burke Channel (084)	74.9	4.87	37.032	100.5	12.60	7.892
All Locations	**61.9**	**2.80**	**675.185**	**103.3**	**12.74**	**223.478**

Table 5. Categories of organisms, by phylum, identified in plankton and stomach samples. The code (capital letters) is used to identify organisms in Tables 7, 9 and 10.

Coelenterata	
COEL	Medusae
SIPH	Siphonophores
Ctenophora	
CTEN	Ctenophores
Turbellaria	
TURB	Turbellarians – flatworms
Annelida	
POLY	Polychaetes – segmented worms
Mollusca	
GAST	Prosobranch gastropods
PELE	Pelecypods
PTER	Pteropods (Ophistobranch gastropods), mostly *Clione sp.*
Arthropoda	
AMPH	Amphipods, mostly gammarid and hyperiid, some caprellid
BARN	Barnacle, unknown stage
BARNc	Barnacle cirriped
BARNn	Barnacle nauplius
CLAD	Cladocerans; *Podon sp.* and *Evadne sp.*
COPE	Copepods (See Table 6 for a list of species)
CRAM	Crab megalopea, including porcillinadea
CRAZ	Crab zoea, including porcillinadea
EUPA	Euphausiid adults
EUPH	Euphausiid, unknown stage
EUPL	Euphausiid larvae (nauplii, protozoea and zoea)
INSE	Insects
ISOP	Isopods, cumaceans and mysids
OSTR	Ostracods
SHRI	Shrimp (natant decapod) zoea
Ectoprocta	
ECTO	Ectoprocts, mostly *Membranipora sp.* larvae (cyphonautes)
Echinodermata	
ECHI	Echinoderm larvae
Chaetognatha	
CHAE	Chaetognaths, mostly *Sagitta sp.*
Chordata	
LARV	Larvaceans, mostly *Oikopleura sp.*, and tunicate larvae
TELA	Teleost larvae
Miscellaneous	
EGGS	Unidentified eggs, polychaete or teleost

Table 6. Copepods identified in plankton and stomach samples. The code (capital letters) is used to identify organisms in Tables 7, 9 and 10.

CNAU	Unidentified copepod nauplii
DIAT	Diatoms, mainly Cosinodiscus

Calanoid copepods

ACAR	*Acartia sp.*
ALON	*Acartia longiremis*
CABD	*Centropages abdominales*
CALA	*Calanus* sp.
CCOL	*Cadacia columbiae*
CGRA	*Chiridius gracilis*
CMAR	*Calanus marshallae*
CPAC	*Calanus pacificus*
EBUN	*Eucalanus bungii*
EELO	*Eucalanus elongatus*
ELON	*Epilabidocera longipedata*
GAID	*Gaidius sp.*
JCAL	Juvenile calanoids, unknown species
MPAC	*Metridia pacifica*
MPSE	*Metridia pseudopacifica*
OBOR	*Oncaea borealis*
PMIN	*Pseudocalanus minitus*
PPAR	*Paracalanus parvus*
TDIS	*Tortanus discaudatus*
UCAL	Unidentified calanoid

Cyclopoid copepods

CANG	*Corcaeeus anglicus*
CYCL	Cyclopoid
OITH	*Oithona* sp.
UCYC	Unidentified cyclopoids

Harpacticoid copepods

UHAR	Unidentified harpacticoids

Table 7. Zooplankton density per set in number of organisms per m^3 of water sampled. Species codes can be found in Table 5 and 6.

Set	Location	Water Volume (m^3)	ACAR	ALON	AMPH	BARN	BARNn	CABD	CALA	CANG	CCOL	CHAE	CLAD
1	Fish Egg Inlet	14.78142	-	22.7	15.7	10.3	-	0.5	-	-	-	4.3	7.6
5	Kwakshua Channel	9.08964	-	169.0	169.0	70.4	-	14.1	-	-	56.3	-	42.2
7	Kwakshua Channel	11.86810	-	17.5	1.0	76.2	-	--	-	-	-	-	6.7
8	Kildidt	11.70812	-	62.9	6.1	153.7	-	19.1	-	-	-	-	32.8
10	Kildidt	13.09545	-	29.3	2.7	26.9	-	88.0	-	-	-	0.3	66.0
13	Spider Anchorage	13.72473	-	135.2	-	33.8	-	16.3	5.8	-	-	-	46.6
14	Thompson Bay	17.04792	-	337.9	0.9	22.5	-	322.9	-	-	-	0.9	52.6
16	Thompson Bay	10.80532	-	204.3	3.7	20.7	-	266.5	-	3.0	-	-	20.7
19	Meyers Passage	18.78570	-	30.7	0.1	316.9	-	6.8	-	-	-	-	3.4
21	Kitasu Bay	8.45425	-	847.9	-	-	45.4	1150.7	-	-	-	-	-
23	Kitasu Bay	8.19370	-	1046.7	-	7.8	-	179.7	-	15.6	-	-	7.8
25	East Higgins Pass	17.23458	-	126.3	-	-	-	14.9	-	-	-	-	-
27	East Higgins Pass	15.55470	-	203.7	0.5	-	47.3	6.2	-	-	-	-	61.7
28	Powell Anchorage	18.50458	-	21.6	1.0	13.8	-	3.9	-	-	-	-	9.1
30	Spiller Channel	15.40766	-	155.8	3.1	8.3	-	20.8	-	-	-	-	-
32	Spiller Channel	19.53003	-	147.5	1.6	9.8	-	32.8	-	-	3.3	-	13.1
34	Hunter Channel	6.55039	-	161.2	15.7	444.9	-	-	-	-	-	0.3	97.7
36	Hunter Channel	8.36512	-	84.2	13.4	639.6	-	30.6	-	-	-	4.1	110.9
38	Burke Channel	3.16016	101.3	-	13.3	45.6	-	15.2	-	-	-	-	75.9
39	Burke Channel	4.28998	126.8	-	-	82.1	-	14.9	-	-	1.9	-	29.8
% Occurrence			10.0	90.0	75.0	85.0	10.0	90.0	5.0	10.0	15.0	25.0	85.0

Table 7 continued...

Set	CMAR	CNAU	COEL	CPAC	CRAM	CRAZ	CTEN	EBUN	ECHI	ECTO	EELO	EGGS	EUPA	EUPH
1	4.3	-	2.2	0.5	0.5	4.3	1.6	-	-	0.5	-	6.5	2.7	-
5	183.1	-	-	-	-	28.2	-	-	-	-	-	70.4	-	-
7	0.3	-	-	-	0.3	23.3	32.7	-	-	5.4	-	-	-	-
8	0.3	-	9.2	0.3	-	389.5	8.9	-	-	-	-	21.9	-	-
10	0.3	-	9.5	0.6	4.0	61.7	5.2	-	-	4.9	0.9	100.2	0.9	-
13	-	-	0.3	-	6.1	61.8	2.0	-	-	1.2	0.3	-	-	23.3
14	0.9	-	0.5	-	8.9	86.3	-	-	-	-	-	-	-	11.3
16	-	-	2.2	-	19.2	144.4	3.0	-	-	8.9	-	-	-	-
19	0.2	-	1.0	-	0.9	15.9	2.4	-	-	40.9	0.2	54.5	-	-
21	-	-	0.9	-	18.0	3.3	-	-	-	-	-	302.8	121.1	-
23	-	-	9.3	-	22.5	87.9	-	-	-	-	-	70.3	-	-
25	0.9	-	0.2	0.2	0.5	1.4	-	-	-	-	-	-	2.8	-
27	-	-	17.0	-	9.8	34.5	-	-	-	6.2	-	4.1	-	-
28	-	-	0.8	-	1.1	13.0	2.8	-	-	1.3	-	-	-	-
30	7.0	-	-	-	2.3	0.8	-	-	-	-	-	105.9	1.1	-
32	1.6	-	0.4	-	0.8	7.4	-	-	-	-	-	85.2	1.6	-
34	-	-	1.4	0.2	0.9	53.9	15.3	-	-	48.9	-	102.6	-	-
36	-	-	0.7	-	0.7	22.7	19.8	-	-	45.9	0.2	65.0	0.5	-
38	-	-	7.0	-	3.2	-	69.0	1.3	35.4	10.1	0.6	-	1.9	45.6
39	-	387.9	12.1	-	-	14.9	270.4	0.9	208.9	14.9	-	-	-	-
% Occurrence	50.0	5.0	85.0	25.0	85.0	95.0	60.0	10.0	10.0	60.0	25.0	60.0	40.0	15.0

Table 7 continued...

Set	EUPL	GAID	GAST	ISOP	JCAL	LARV	MPSE	OBOR	OITH	OSTR	PELE	PMIN	POLY	PPAR	SHRI	SIPH
1	5.4	-	-	-	28.7	5.4	76.9	-	-	-	-	7.0	0.5	1.1	-	0.5
5	197.1	-	98.6	-	535.1	98.6	5477.9	-	42.2	-	14.1	112.7	14.1	56.3	-	-
7	7.1	-	6.7	0.3	7.1	5.4	48.5	-	-	-	-	8.1	5.4	-	3.7	-
8	27.3	-	10.9	-	16.7	8.2	3.4	-	-	2.7	-	21.9	-	-	22.5	0.3
10	119.7	-	-	-	77.6	58.6	0.3	-	12.2	-	-	19.5	-	-	15.6	5.5
13	28.0	-	12.8	1.7	62.4	31.5	-	-	14.0	-	-	5.8	-	12.8	23.9	37.0
14	30.5	-	-	-	145.0	22.5	-	-	7.5	-	-	67.6	-	-	12.2	-
16	19.2	-	11.8	-	74.0	32.6	-	-	-	-	-	14.8	-	3.0	27.4	31.1
19	264.2	-	6.8	-	15.1	6.8	0.4	-	-	-	-	37.5	0.5	-	0.5	-
21	30.3	-	-	-	171.7	181.7	-	-	15.1	-	-	863.0	-	-	33.6	0.5
23	7.8	-	31.2	-	71.8	93.7	-	-	-	-	-	156.2	-	-	4.9	-
25	3.5	-	-	-	193.3	-	37.6	-	3.7	-	-	304.5	-	-	0.2	-
27	2.6	-	2.1	-	49.4	18.5	1.0	-	-	-	-	129.6	0.5	-	26.7	-
28	0.4	-	-	1.8	1.4	0.4	0.4	-	0.4	0.1	-	3.0	0.4	0.4	2.8	-
30	0.5	-	-	-	56.9	-	18.7	-	-	-	-	16.6	3.6	-	1.0	-
32	-	-	4.1	-	168.8	-	43.0	-	-	-	-	19.7	7.0	-	1.2	-
34	68.9	-	4.9	-	86.4	219.8	1.4	-	-	-	-	4.9	4.9	4.9	2.1	-
36	58.6	-	19.6	0.2	173.8	65.0	25.6	-	-	-	11.5	30.6	3.8	-	11.2	-
38	66.5	1.9	45.6	-	1093.6	344.3	22.8	1.9	0.6	81.0	172.1	182.3	15.8	35.4	6.3	-
39	105.4	-	15.9	-	1150.6	238.7	2.8	-	-	59.7	104.4	104.4	52.2	67.1	-	-
% Occurrence	95.0	5.0	65.0	20.0	100.0	85.0	75.0	5.0	40.0	20.0	20.0	100.0	60.0	40.0	85.0	30.0

Table 7 continued...

Set	TDIS	TELA	UCYC	UHAR	Total
1	0.5	-	-	-	213.5
5	-	-	-	-	7464.4
7	-	1.3	-	-	278.2
8	-	0.3	-	-	843.3
10	-	0.3	-	-	740.8
13	1.2	-	-	-	602.9
14	-	0.5	-	-	1173.4
16	-	-	-	-	958.7
19	-	-	-	-	862.8
21	-	0.5	-	-	3849.5
23	-	-	-	-	1882.1
25	-	-	-	-	765.0
27	65.8	-	-	-	768.1
28	1.7	0.1	-	-	165.8
30	2.1	-	-	-	494.5
32	-	-	-	-	644.9
34	-	-	-	-	1443.0
36	-	4.3	-	-	1550.7
38	-	-	6.3	0.6	2616.4
39	-	-	-	-	3183.7
% Occurrence	25.0	35.0	5.0	5.0	

Table 8. Herring stomach fullness (empty, trace, half full, or full) and state of digestion (fresh, partly digested, mostly digested or totally digested).

	State of digestion				
Fullness	**1 - fresh**	**2 - partly**	**3 - mostly**	**4 - totally**	**Total**
0 + herring					
0 - empty	9	53	17	7	**86**
1 - trace	-	31	4	-	**35**
2 - half	-	-	-	-	**-**
3 - full	-	-	-	-	**-**
Total	**9**	**84**	**21**	**7**	**121**
1 + herring					
0 - empty	9	37	10	15	**71**
1 - trace	5	17	2	-	**24**
2 - half	3	2	-	-	**5**
3 - full	-	3	-	-	**3**
Total	**17**	**59**	**12**	**15**	**103**

Table 9. Quantity and percent occurrence of identifiable prey items in 0+ herring stomachs (n) by location. Tables 5 and 6 describe organism abbreviations.

	Fish Egg Inlet		Kwakshua Channel		Kitasu Bay		Powell Anchorage		Spiller Channel		Hunter Channel	
N	20		20		20		19		19		19	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
ALON	2	5	1	5	77	60	30	47.37	228	84.21	-	-
AMPH	-	-	5	25	-	-	-	-	-	-	1	5.26
BARNc	-	-	8	25	-	-	1	5.26	6	26.32	32	73.68
BARNn	10	30	58	90	-	-	228	89.47	58	73.68	65	63.16
CABD	-	-	3	15	135	70	2	5.26	12	21.05	2	5.26
CANG	3	15	-	-	1	5	101	52.63	18	52.63	3	15.79
CLAD	33	55	209	95	-	-	467	89.47	382	89.47	2	10.53
COPE	1	5	-	-	-	-	82	94.74	12	47.37	-	-
CRAZ	-	-	4	20	-	-	2	10.53	1	5.26	1	5.26
CYCL	-	-	-	-	-	-	3	5.26	-	-	-	-
DIAT	9650	100	1385	75	-	-	157	68.42	115	57.89	14	31.58
ECTO	12	35	16	40	-	-	116	78.95	24	52.63	7	21.05
EGGS	26	30	67	60	608	75	1	5.26	391	84.21	23	47.37
EUPH	-	-	10	5	-	-	-	-	-	-	-	-
EUPL	-	-	5	25	1	5	1	5.26	-	-	-	-
GAST	-	-	-	-	-	-	1	5.26	-	-	-	-
INSE	-	-	-	-	-	-	-	-	-	-	1	5.26
LARV	-	-	132	75	4	5	-	-	-	-	25	52.63
OITH	-	-	-	-	-	-	8	26.32	-	-	-	-
PELE	1	5	45	80	-	-	55	78.95	38	63.16	26	57.89
PPAR	1	5	2	10	-	-	32	15.79	6	21.05	-	-
SHRI	-	-	1	5	-	-	-	-	-	-	-	-
TURB	13	45	2	10	138	95	13	63.16	19	57.89	16	52.63
UCAL	20	30	354	90	311	90	604	100	592	89.47	42	47.37
UHAR	1	5	1	5	-	-	-	-	-	-	-	-

Table 10. Quantity and percent occurrence of identifiable prey items in 1+ herring (n) by location. Tables 5 and 6 describe organism abbreviations.

	Fish Egg Inlet		Kwakshua Channel		Kitasu Bay		Powell Anchorage		Spiller Channel		Hunter Channel	
N	20		20		18		13		4		17	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
ALON	-	-	93	70	121	38.89	2	15.38	2	25	1	5.88
AMPH	1	5	27	65	-	-	1	7.69	-	-	1	5.88
BARNc	3	10	8	30	1	5.56	1	7.69	-	-	24	35.29
BARNn	-	-	30	55	-	-	1	7.69	-	-	8	23.53
CABD	-	-	18	35	81	44.44	2	7.69	-	-	11	11.76
CANG	-	-	-	-	-	-	19	38.46	-	-	-	-
CGRA	13	35	-	-	-	-	-	-	-	-	-	-
CHAE	-	-	1	5	-	-	-	-	-	-	-	-
CLAD	-	-	20	40	-	-	-	-	-	-	-	-
CMAR	-	-	5	10	-	-	-	-	-	-	-	-
COPE	-	-	-	-	-	-	1	7.69	-	-	-	-
CRAM	-	-	2	5	9	27.78	25	46.15	2	25	10	29.41
CRAZ	-	-	41	70	-	-	82	84.62	4	50	20	47.06
DIAT	145.3	60	1080	85	-	-	2	15.38	-	-	-	-
EGGS	-	-	89	45	65	33.33	-	-	9	25	-	-
ELON	5	15	-	-	-	-	-	-	-	-	-	-
EUPA	5	15	3	10	-	-	-	-	10	50	1	5.88
EUPH	-	-	-	-	2	5.56	-	-	1	25	-	-
EUPL	-	-	20	35	-	-	-	-	-	-	-	-
GAST	-	-	2	5	-	-	-	-	-	-	-	-
INSE	-	-	1	5	-	-	-	-	-	-	-	-
ISOP	1	5	1	5	-	-	-	-	-	-	-	-
LARV	-	-	354	80	31	16.67	-	-	-	-	24	5.88
MPAC	46	5	1281	90	-	-	-	-	-	-	-	-

Table 10 continued...

	Fish Egg Inlet		Kwakshua Channel		Kitasu Bay		Powell Anchorage		Spiller Channel		Hunter Channel	
N	20		20		18		13		4		7	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
OITH	-	-	2	5	-	-	-	-	-	-	-	-
PELE	-	-	5	20	-	-	-	-	-	-	-	-
PMIN	-	-	2	10	-	-	-	-	-	-	-	-
POLY	-	-	17	15	-	-	-	-	-	-	-	-
PPAR	-	-	8	20	-	-	-	-	-	-	-	-
PTER	1	5	16	20	-	-	-	-	-	-	-	-
SHRI	-	-	5	10	6	11.11	9	30.77	1	25	1	5.88
TELA	-	-	3	5	-	-	-	-	-	-	-	-
TURB	21	45	25	55	39	66.67	21	61.54	4	50	7	23.53
UCAL	603	95	173	100	160	55.56	6	15.38	-	-	110	41.18
UHAR	-	-	1	5	-	-	1	7.69	-	-	-	-

Table 11. Herring predator stomach contents. When possible, gut species were identified to species and total length (mm) and weight (g) were recorded.

Set	Species	Length (mm)	Weight (g)	Stomach Weight (g)	Gut Species	Quantity	Gut Species Length (mm)	Gut Species Weight (g)
7	Pink	495	1500	13.39	-	empty	-	-
7	Pink	524	1700	11.75	-	empty	-	-
18	Pink	508	1600	10.91	-	empty	-	-
20	Pink	572	2600	20.26	-	empty	-	-
20	Pink	540	2000	19	-	empty	-	-
20	Pink	533	1600	19	Herring	1	72	4.72
22	Pink	540	2000	31.61	Herring	1	112	15.29
22	Coho	648	3400	48.11	Herring	1	127	11.91
22	Coho	679	4300	43.17	-	-	-	3.27
					-	-	-	3.86
23	Sockeye	495	1500	6.47	-	empty	-	-
24	Chum	660	4000	70.5	Euphausiids	-	-	15.25
24	Pink	559	2100	28.63	Euphausiids	-	-	13.77
24	Chub Mackeral	556	2000	16.96	Euphausiids	-	-	12.27
24	Chub Mackeral	552	2000	10.81	Euphausiids	-	-	6.91
24	Chub Mackeral	552	2000	17.87	Euphausiids	-	-	12.7
24	Chub Mackeral	559	2000	20.05	Euphausiids	-	-	16.63
24	Chub Mackeral	546	2000	17.24	Euphausiids	-	-	10.07
24	Chub Mackeral	552	2000	17.47	Euphausiids	-	-	25.97
24	Chub Mackeral	594	2000	23.46	Euphausiids	-	-	0.62
24	Chub Mackeral	581	2000	15.36	Euphausiids	-	-	26.74
24	Chub Mackeral	559	2000	14.47	Euphausiids	-	-	15.83
24	Chub Mackeral	568	2000	16.49	Euphausiids	-	-	9.51
24	Chub Mackeral	540	2000	15.86	Euphausiids	-	-	30.99
24	Chub Mackeral	540	2000	15.08	Euphausiids	-	-	36.37
25	Chub Mackeral	533	2100	19.75	Euphausiids	-	-	7.22
25	Pink	483	1500	8.06	-	-	-	2.44
					Herring	3	-	2.37
25	Chum	686	4400	61.84	Euphausiids	-	-	0.92
25	Chub Mackeral	556	2100	23.15	Euphausiids	-	-	11.09
25	Pink	518	1800	12.68	Euphausiids	-	-	3.19
25	Chum	635	3700	32.15	-	-	-	2.47
25	Chub Mackeral	549	2100	18.14	Euphausiids	-	-	4.35
25	Chub Mackeral	524	2100	17.52	Euphausiids	-	-	21.12
25	Chub Mackeral	591	2100	18.75	Euphausiids	-	-	20.94
25	Chub Mackeral	559	2100	15.81	Euphausiids	-	-	1.96
26	Pink	552	2100	18.29	Herring	-	-	15.38
					Euphausiids	-	-	77.49
26	Chum	597	2400	3.73	Euphausiids	-	-	12.94
27	Spiny Dogfish	597	900	35.08	Euphausiids	-	-	0.79
27	Spiny Dogfish	648	1000	38.62	Euphausiids	-	-	2.12

Table 11 continued...

Set	Species	Length (mm)	Weight (g)	Stomach Weight (g)	Gut Species	Quantity	Gut Species Length (mm)	Gut Species Weight (g)
27	Spiny Dogfish	787	2400	164.91	Pollock	1	-	58.59
					-	-	-	50.89
27	Spiny Dogfish	787	2400	164.91	-	-	-	2.68
28	Chum	737	6000	40.96	-	-	-	0.96
					Herring	-	54	1.76
					Herring	-	51	1.59
28	Starry Flounder	489	1800	16.85	-	-	-	7.22
30	Coho	635	2500	22.09	Euphausiids	9	-	0.68
38	Pink	546	2000	8.7	-	empty	-	-
38	Spiny Dogfish	667	2300	51.88	-	4	-	12.57
					Herring	1	-	3.79
38	Pink	552	1800	7.28	-	empty	-	-
38	Spiny Dogfish	584	1000	36.35	-	-	-	1.24